Endura EM945G

Product Manual

RadiSys
THE POWER OF WE

www.radisys.com

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Preface

About This Guide

This user manual describes main features and specifications of the Endura EM945G motherboards and instructs how to install and configure the motherboards.

Notational Conventions

This manual uses the following conventions:

- `Courier New`: Indicates the screen text and syntax strings.
- *`Courier New Italic`*: Indicates the variable parameters.
- All numbers are decimal unless otherwise stated.
- Bit 0 is the low-order bit. If a bit is set to 1, the associated description is true unless otherwise stated.

Installation Notes

When installing this motherboard into a suitable chassis, refer to the following notes:

- Read and save all instructions.
- Always disconnect Cord/Plug before installation or upgrade. Parts of the motherboard can remain powered even when the power supply is switched off unless the cord is disconnected.
- Pay attention to the safety warnings included in this document.
- When installing expansion cards, pay attention to the maximum loads detailed in this document. Use only UL approved peripheral cards.
- Route wiring away from sharp edges, heat sources and cooling fans.
- Pay attention to the thermal issues described in this document. The motherboard requires suitable airflow to maintain an ambient temperature within its operating range.

Safety Notices

Item	Description
Battery	Danger of the explosion if battery is incorrectly replaced or removed. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of batteries according to the manufacturer's instructions. Do not use a conductive instrument, as a short-circuit may cause the cell to explode. Always replace the cell with one of the same type. This product uses a CR2032 cell. Dispose of a spent cell promptly – do not recharge, disassemble or incinerate. Keep cells away from children.
LAN (Local Area Network) Connector	This product may include an RJ45 LAN connector (see product options). Do not connect to anything other than an Ethernet LAN.

Item	Description
Thermal Interface Material	This product may contain thermal interface material between devices and heat sinks. This can cause irritation and can stain clothing. Avoid prolonged or repeated contact with the skin and wash thoroughly with soap and water after handling. Avoid contact with eyes and inhalation of fumes. Do not ingest.
Anti-static Precautions	This product contains static-sensitive components and should be handled with care. It is recommended that the product be handled in a Special Handling Area (SHA) as defined in EN100015-1:1992. Such an area has working surfaces, floor coverings and chairs connected to a common earth reference point. An earthed wrist strap should be worn whilst handling. Other examples of static-sensitive devices are the memory modules and the processor. Failure to employ adequate anti-static measures can cause irreparable damage to components on the motherboard.
Electromagnetic Compatibility	This product is designed to meet the following EMC standards when installed in a suitable chassis. FCC Class B (Title 47 of Code of Federal Regulations, parts 2 & 15, subpart B) EN55022:1998 Class B EN55024:1998
Safety	This product complies with the American Safety Standard UL60950 when installed in a suitable chassis.
Legal Directives	This product complies with the relevant clauses of the following European Directives: Low Voltage Directive: 73/23/EEC EMC Directive: 89/336/EEC

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1. Overview

The EM945G motherboard is part of the RadiSys® Endura product line, which specifically targets at the embedded markets and applications with a lifetime of five years, including transaction terminals, medical equipments, test and measurement, gaming, industrial automation, enterprise systems, and so forth.

Products are fully revision controlled and any change to form, fit or function will be conveyed via Product Change Notification.

1.1 Product Specification Overview

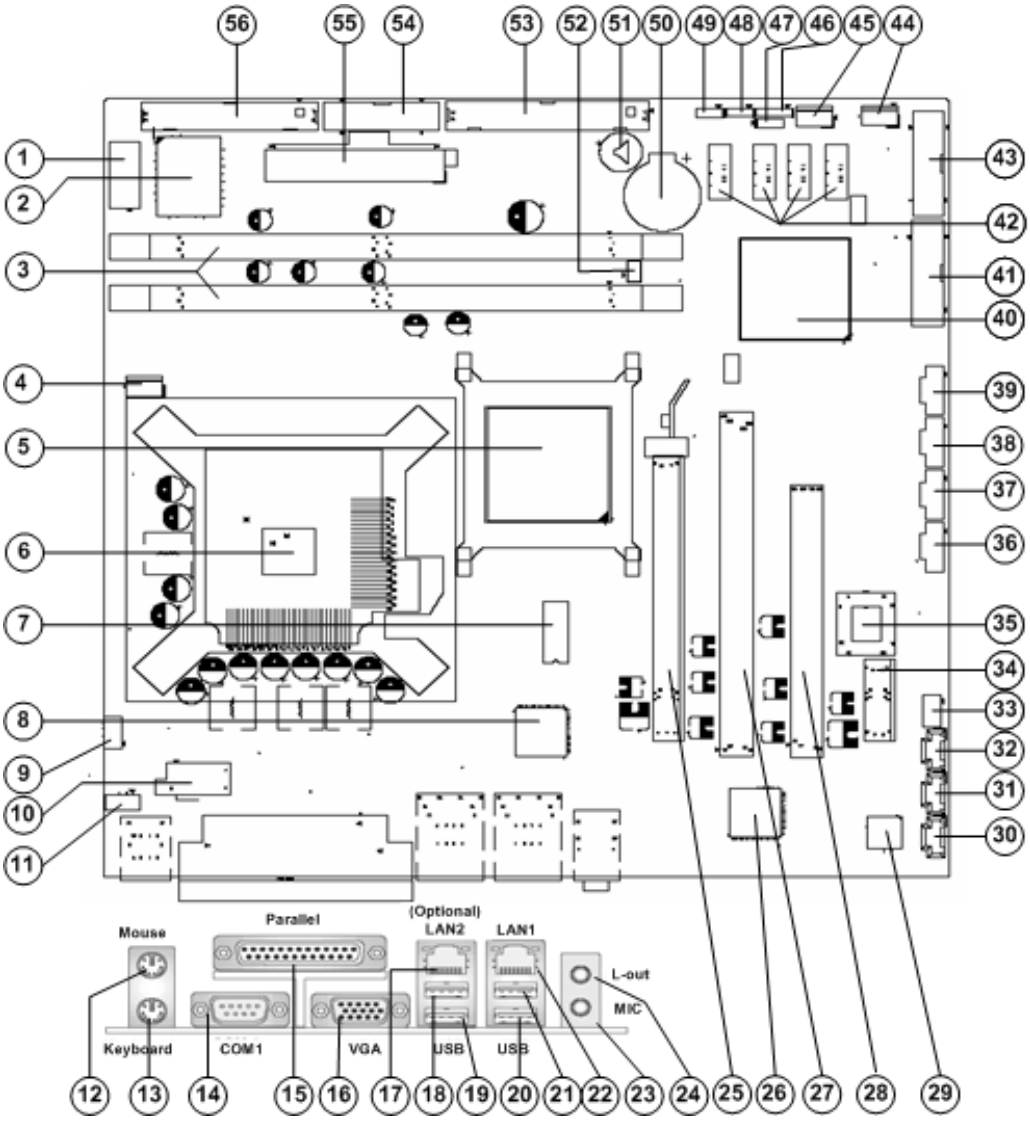
Main Board	EM945G
Form Factor	uATX, 9.6” x9.6”, 4 expansion slots
Processor	Support for Intel® processors in an LGA775 socket with bus speeds of 1066MHz, 800MHz and 533MHz
Chipset	Intel 945G GMCH + Intel ICH7/ICH7R, depending on the product SKU
Memory	• Two Channel DDR2 400/533/667 • Support 2 DDR DIMMs (3.24GB maximum available memory)
System BIOS Feature	• FWH-4Mb (wake on LAN boot) • Phoenix Award BIOS code • ACPI supported, S1 default • Hardware monitor supported
Super I/O	Winbond® PC8374L
Hardware Monitor	NS LM96000CIM
RTC	Intel ICH7/ICH7R (Selected Boards)
Battery Cell	Battery, Coin Lithium, 3.0V, 220mAh, CR2032
IDE Interface	• PCI Bus master enhanced IDE (ICH7R/ICH7) • Single Ultra ATA 100/66/33 interface supporting hard disks and ATAPI drives
Serial ATA	• Independent DMA operation on 4 ports • Data transfer rates up to 300Mbps
Audio	Audio on board with Intel HD Audio interface operation option, using SIGMATEL STAC9200
LAN	Dual Intel 82573L controllers or single 82562GZ PHY
USB	USB 2.0 Host Controller that totally supports up to 8 ports: • Rear: One dual stack and one dual stack w/ RJ-45 LAN • Front: 1x5 header x4
Expansion slots	• Slot 1: PCI Express x1Slot • Slot 2: PCI Slot • Slot 3: PCI Riser Slot • Slot 4: PCI Express x16 Slot

I/O Ports	Rear I/O: PS/2 keyboard and mouse; Analog VGA; Bi-directional/EPP/ECP parallel port; COM1 RS232; One or two dual USB + RJ45 stacks; Audio jack stack (2 jacks) Header; Connectors: • USB; MIC-IN; LINE-OUT; LINE-IN; • GPIO 2 x 10 pin with housing • SMbus 1 x 4 pin with housing • COM2 2 x 5 pin with housing • Kbd/Mouse 1 x 4 pin with housing • Remote sensor 1 x 2 pin with housing • FDD 1 x FDD connector
Power Connectors	24 Pin ATX power connector and 8 Pin ATX_12V connector
Power Management	Dark Green, ACPI 2.0 compliant, SMBIOS 2.3, PC99 Spec.
System Management	Voltage, temperature and fan monitoring (3 fans) Lithium cell voltage monitoring Automatic fan speed control (3 fans) SMBus header
Security	Header for TPM 1.2 compliant module

1.2 Motherboard Layout

The following figure shows the layout of the EM945G motherboard with the major components identified.

Figure 1. Motherboard Layout and Component Identification

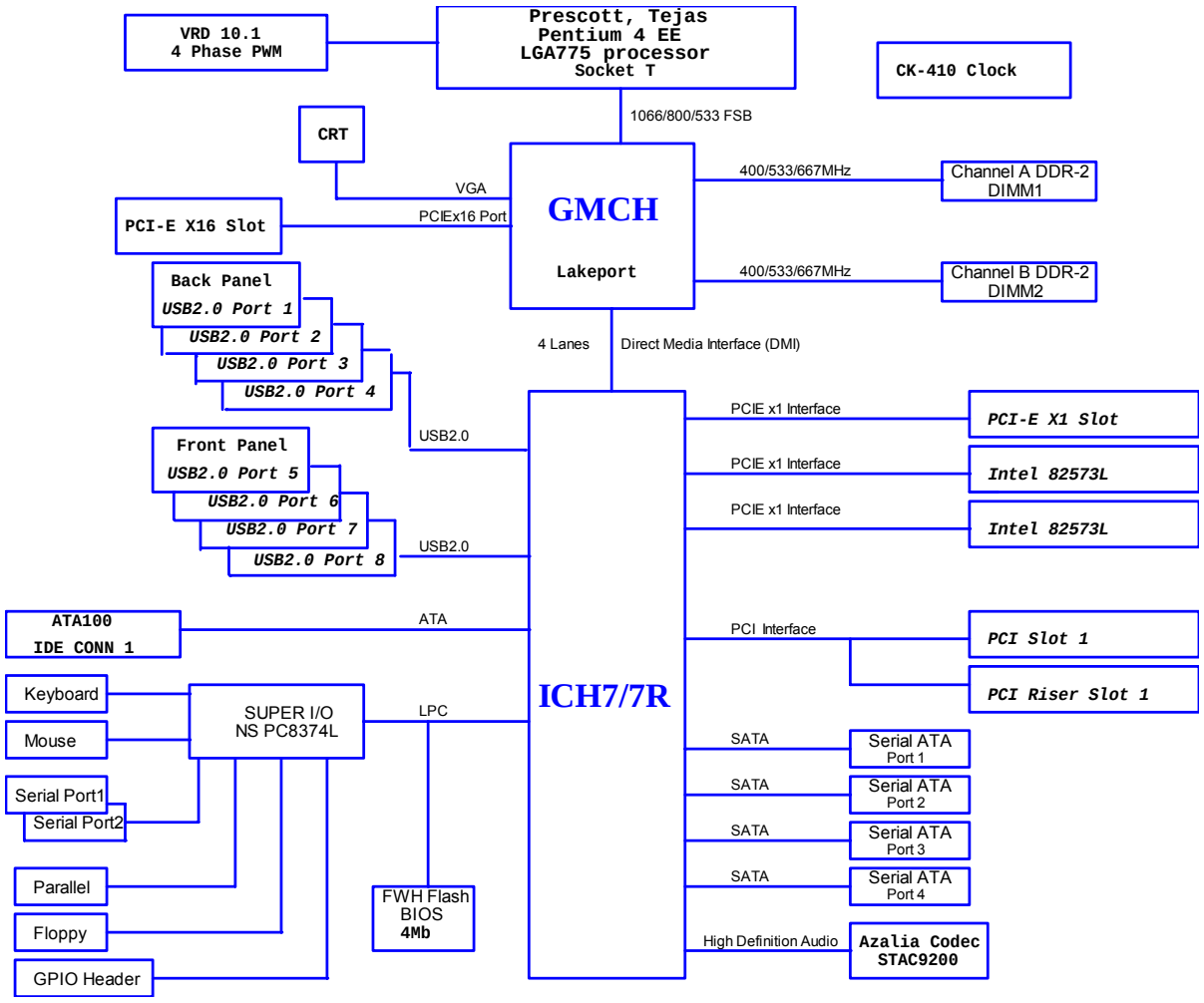


Item	Description	Item	Description	Item	Description
1	Serial port 2 header	20	Back panel USB 2.0 port 5	39	USB port 6 header
2	Super IO	21	Back panel USB 2.0 port 7	40	I/O controller hub (ICH7/7R)
3	Memory DIMM sockets (2)	22	Giga or 10/100 Ethernet port (RJ45)	41	Front panel header
4	CPU FAN connector	23	Microphone input jack	42	SATA connectors
5	GMCH	24	Audio line output jack	43	TPM header
6	775-pin socket for processor	25	PCI Express x16 slot	44	System fan connector
7	Clock generator	26	Giga or 10/100M Ethernet controller	45	Chassis fan connector
8	Giga Ethernet controller (optional)	27	PCI Riser slot	46	Speaker header
9	PS/2 mouse header	28	PCI slot	47	Operation Mode Jumper
10	12V power connector	29	HD Audio CODEC	48	BIOS ROM jumper
11	PS/2 keyboard header	30	Stereo audio (CD) line input header	49	Clear CMOS Jumper
12	PS/2 mouse (green)	31	Stereo audio line output header	50	RTC battery
13	PS/2 keyboard (purple)	32	Stereo audio (microphone) input header	51	Buzzer
14	Serial port 1	33	SMBus header	52	Remote thermal sensor
15	Parallel port	34	PCI Express x1 slot	53	IDE connector
16	VGA monitor	35	BIOS ROM (FWH)	54	GPIO header
17	Giga Ethernet port (RJ45) (optional)	36	USB port 0 header	55	Primary power supply connector
18	Back panel USB 2.0 port 1	37	USB port 2 header	56	FDD connector
19	Back panel USB 2.0 port 3	38	USB port 4 header		

1.3 Block Diagram

The following figure shows a block diagram of the EM945G motherboard:

Figure 2. Block Diagram



1.4 Board Product Ordering Codes and Content

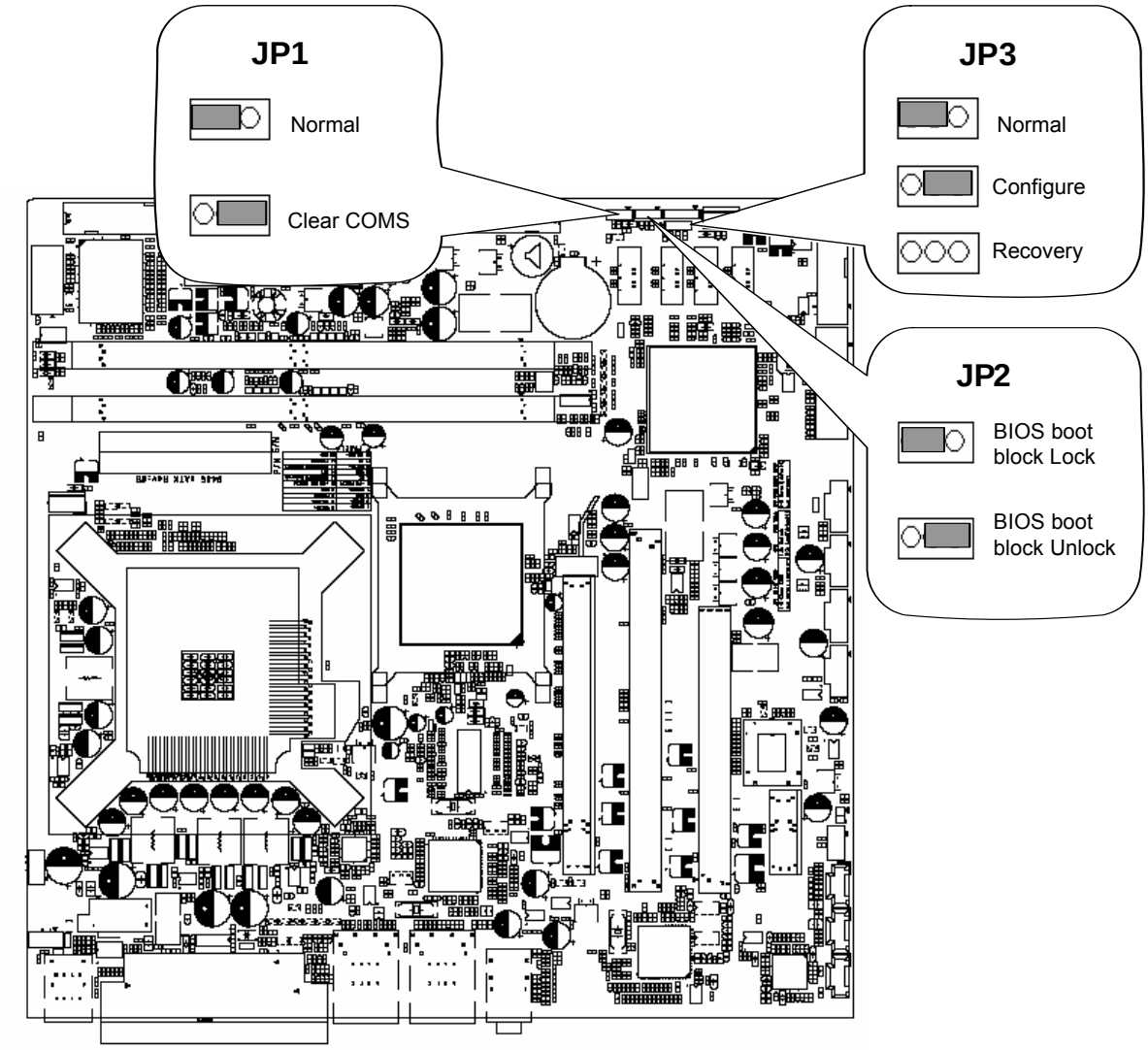
The following product codes and content are available and are subject to change.

Function	EM1W03-0-0	EM2G03-0-0
Chipset	Intel 945G Intel ICH7	Intel 945G Intel ICH7R
Processor	LGA775	LGA775
LAN	10/100	10/100/Gbit
LAN remote boot	Yes	Yes
LAN wake-up	Yes	Yes
Audio	HDA, 2 jacks, 3 headers	HDA, 2 jacks, 3 headers
Watchdog	Yes	Yes
Analog VGA	Via VGA port	Via VGA port
IEEE 1394b	No	No
Enhanced programmable controller	No	No
Installed processor	No	No
Installed memory	No	No

1.5 Configuration

The majority of the configuration of the motherboard is done through the Setup utility built into the BIOS. There are, however, a number of jumpers that control the operation of the motherboard as described below. Some jumpers are not fitted to certain products.

Figure 3. Jumpers



1.5.1 Operation Mode Selection (JP3)

This JP3 selects one of these operating modes for the motherboard:

Normal Mode	(Factory default) Jumper installed between pin1&2. This is the position the jumper should be in for normal operation of the motherboard.
Recovery Mode	With no jumper installed, the recovery mode is entered. The motherboard does not boot and waits until a valid recovery diskette is detected and then copies new BIOS into the ROM. The motherboard must be powered down and then re-powered with the jumper in the normal position.
Configure Mode	With the jumper in this position (jumper installed between pin 2&3) the motherboard automatically runs the BIOS Setup utility regardless of the state of the Setup disable flag that can be set in the BIOS defaults. In this mode, the CMOS RAM contents are ignored and the defaults are used to configure the motherboard.

1.5.2 BIOS Boot Block Write Protect Jumper (JP2)

A jumper installed between pins 1 & 2 (factory default), or no jumper installed, enables changes to contents of BIOS ROM boot block (unlocked position). Some motherboard applications may want to have boot block write-protected BIOS. This can be provided via the BIOS boot block write protection jumper facility. If a jumper is installed between pins 2 & 3 (locked position), the contents of BIOS ROM boot block cannot be changed in any way.

1.5.3 Clear CMOS Jumper (JP1)

Installing a jumper between pins 1 & 2 clears (resets) the CMOS. A jumper installed between pins 2 & 3 (factory default), or no jumper installed, is the normal operating configuration.

1.5.4 Front Panel Connector (Header)

The primary controls and indicators for the motherboard are connected via the front panel connector, also called front panel header, using either a single ribbon cable to a front panel assembly, or using a number of small PC-standard connectors.

Power LED	Connects either a single-color LED (usually green) or a two-terminal bi-color LED (usually green/yellow) to indicate the powered status of the motherboard. In both cases, the 'green' anode should be attached to pin 2 of the front panel connector. See the Indicators section later in this document for further information.
Power Switch	If the motherboard is used with a soft-switch power supply, a momentary switch should be connected between pins 6 and 8 of the power connector. If the switch is closed for greater than approximately 4 seconds, the motherboard powers off immediately, regardless of the state of the operating system, losing any system context information. This input is redundant when using a hard-switch power supply.
Reset Switch	If used, a momentary switch connected between pins 5 and 7 will cause the motherboard to restart when closed.
Hard Disk LED	To indicate hard disk activity on either of the two ATA channels, a single color LED should be connected between pins 1 (anode) and 3.
Speaker	Connect an external speaker between pins 10 and 12 or 10 and 16. This is used only for the PC beep functions. The speaker should typically be 8Ω.
Tamper Switch	To make use of the tamper detection logic of the motherboard, connect a momentary switch between pins 18 and 20. The switch should be open when the chassis is closed.

1.5.5 Alternate Power LED

The power LED function on the front panel connector is duplicated on the Alternate Power LED connector for use with LEDs cabled to a 3-pin connector. Do not use both the primary (front panel) and alternate connectors simultaneously.

1.6 RAID Function Configuration

Selected boards provide support for RAID 0, 1, 5, 10 via the ICH7R RAID controller. To configure the RAID function, do the following:

1. Enter the BIOS Setup screen, select `Integrated Peripherals`, and then `OnChip IDE Device`. Set the SATA mode to `RAID`, and then save the changes and exit.

2. Intel Matrix Storage Manager Option ROM is integrated in all the system BIOS supporting Intel chipsets. When system starts POST, showing Intel Matrix Storage Manager Option ROM screen, press Ctrl + I to enter the RAID configuration utility Intel RAID for Serial ATA screen optional items. On the main menu, you can create or delete the RAID volume as needed, and then save the changes and exit.
3. Reboot from CD ROM. When the system prompts you whether to install third party SCSI or RAID driver appears, press F6 to install RAID driver. Insert Intel IAA RAID XP Driver for ICH7R (NH82801GR) into disk A, and then press Enter to continue the installation.

2. Motherboard Description

2.1 Supported Processors

The EM945G motherboard supports Intel® Pentium® D, Pentium 4, and Celeron® D processors in a 775-pin LGA socket. The following table lists some of the currently supported processors. For more information about the supported processors and technical support, visit the RadiSys Web site at www.radisys.com.

Processor Type	Processor Speed	CPU Bus Speed	Cache Size
Pentium D, 830	3.00 GHz	800 MHz	2MB
Pentium D, 820	2.80 GHz	800 MHz	2MB
Pentium 4, 670	3.80 GHz	800 MHz	2MB
Pentium 4, 651	3.40 GHz	800 MHz	2MB
Pentium 4, 551	3.40 GHz	800 MHz	1MB
Pentium 4, 541	3.20 GHz	800 MHz	1MB
Celeron D, 351	3.20 GHz	533 MHz	256 KB
Celeron D, 341	2.93 GHz	533 MHz	256 KB
Celeron D, 340J	2.93 GHz	533 MHz	256 KB

NOTE An on-board voltage regulator generates the voltage for the CPU. Both the processor voltage and the operating frequency are automatically adjusted by the motherboard to suit the installed processor.

2.2 System Memory

The GMCH integrates a system memory DDR2 controller with two, 64-bit wide interfaces. The memory controller interface is fully configurable through a set of control registers. Features of the GMCH memory controller include:

- Maximum supported memory size is 4 GB, with maximum useable memory of approximately 3.24 GB.
- Directly supports one or two channels of memory (each channel consisting of 64 data lines)
- The memory channels are interleaved: Addresses are ping-ponged between the channels after each cache lien (64-B boundary).
- Supports DDR2 533, and DDR2 667
- Available bandwidth up to 5.3Gbps (DDR2 667) for single-channel mode or dual-channel asymmetric mode and 10.7Gbps (DDR2 667) in dual-channel Interleaved mode
- Supports DDR2 memory DIMM frequencies of 533MHz, and 667MHz. The speed used in all channels is the speed of the slowest DIMM in the system.
- Supports 256-Mb, 512Mb, and 1Gb DDR2 technologies for x8 and x16 device.
- Supports four banks for all DDR2 devices up to 512-Mbit density. Supports eight banks for 1-Gbit DDR2 devices.

- DDR2-667 1Gbit technology or DDR2-667 4-4-4 is not supported.
- Supports only un-buffered DIMMs.
- Supports opportunistic refresh.
- In dual channel mode, the (G) MCH supports 32 simultaneously open pages.
- Supports the Serial Presence Detect (SPD) scheme for DIMM detection.
- Supports Suspend-to-RAM via CKE.
- Supports configurations defined in the JEDEC DDR2 DIMM specification only.
- Directly supports two channels of non-ECC DDR2 DIMMs.
- Supports Partial Writes to memory using Data Mask (DM) signals.
- Supports a burst length of 8 for single-channel and dual-channel interleaved and asymmetric operating modes.
- Supports Enhanced Memory Interleave.

NOTE When using the on-board video controller, the frame buffer is held within system memory and less memory is available to the operating system.

2.3 Chipset

The motherboard is based on the Intel 945G chipset with the ICH7 or ICH7R I/O controller.

2.3.1 945G GMCH

The primary role of a GMCH in a system is to manage the flow of information between its interfaces: the processor interface (FSB), the system memory interface (DRAM controller), the integrated graphics interface (82945G GMCH only), the external graphics interface (PCI Express), and the I/O Controller through DMI interface. This includes arbitrating between the four interfaces when each initiates transactions.

The GMCH supports one or two channels of DDR2 SDRAM. The GMCH also supports the PCI Express based external graphics attach. To increase system performance, the GMCH incorporates several queues and a write cache. The GMCH also contains advanced desktop power management logic. The device package is a 1202 Flip Chip Ball Grid Array (FCBGA).

2.3.2 ICH7/7R IO Controller

The ICH7/7R provides extensive I/O support. Functions and capabilities include:

PCI Express

- 4 PCI Express root ports
- Fully PCI Express 1.0a compliant
- Support for full 2.5Gbps bandwidth in each direction per x1 lane
- Two virtual channel support for full isochronous data transfers

PCI Bus Interface

- Supports PCI Rev 2.3 Specification at 33 MHz
- Support for 64-bit addressing on PCI using DAC protocol

Integrated Serial ATA Host Controllers

- Four ports
- Data transfer rates up to 3.0Gbps (300 Mbps)
- Integrated AHCI controller (ICH7R products only)

Integrated IDE Controller

- Independent timing of up to two drives
- Ultra ATA/100/66/33, BMIDE and PIO modes

Intel High Definition Audio Interface

- Supports multimedia channel, 32-bit sample depth, 192kHz sample rate output
- AC-Link for Audio and Telephony Codec

Integrated LAN Controller

- Integrated ASF Management Controller
- WfM2.0 and IEEE802.3 Compliant
- LAN Connect Interface (LCI)
- 10/100Mbps Ethernet Support

Power Management Logic

- ACPI 2.0 compliant
- ACPI-defined power states (S0, S3-S5, C0, C1)

External Glue Integration

- Integrated Pull-op, Pull down and Series Termination resistors on IDE, processor I/F
- Integrated Pull-down and Series resistors on USB

Enhanced DMA Controller

- Two cascaded 8237 DMA controller,
- Supports LPC DMA

SMBus

- Supports SMBus 2.0 Specification
- Host interface allows processor to communicate via SMBus

High Precision Event Timers

- Advanced operation system interrupt scheduling
- Timers Based on 82C54
- System timer, Refresh request, Speaker tone output

Real-Time Clock

- 256-byte battery-backed CMOS RAM

Interrupt

- Interrupt Controller
- Supports up to eight interrupt pins
- Supports PCI 2.3 Message Signaled Interrupts

TPM1.2

- Support for Security Device (Trusted Platform Module) connected to LPC

2.4 Video

- Integrated Intel GMA950 video controller: Intel IPD group Embedded Graphics or GMA (Extreme) drivers and video BIOS
- Analog RGB output with DDC2B: Graphics resolution up to 2048 x 1536 pixels with 32-bit color support at 75Hz 15-pin D-sub connector support
- Supports PCI-E graphics cards and ADD2 cards

2.5 Disks

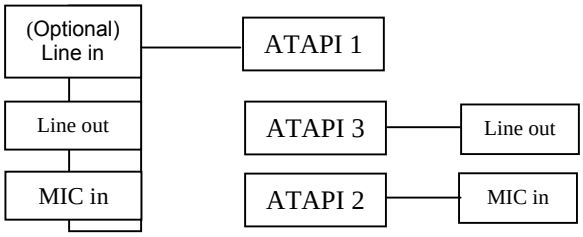
- Four 300Mbps SATA ports with locking headers
- One Ultra ATA/100 interface via on-board 40-way boxed header
- 40/80-pin cable host-side detection or forced in BIOS
- Support for hard disks and ATAPI drives
- BIOS support for 48-bit LBA (ATA drives >137GB)
- Support for USB drives including boot
- Support for RAID 0, 1, 5, 10 by ICH7R as RAID controller (Only SKU with ICH7R)

2.6 Audio

The motherboard audio system comprises the chipset ICH7(R) digital audio controller and SigmaTel STAC9200 audio CODEC with Intel High Definition (HD) Audio compatible mode.

On-board ATAPI connectors	• ATAPI 1: Line input connector (black) • ATAPI 2: Stereo AUX/MIC input connector (white) • ATAPI 3: Stereo Line output connector (yellow)
Two I/O panel 3.5mm plug and play audio jacks	Default connections include: • Stereo microphone input (with support for microphone bias) • Stereo Line output with headphone drive capability
On-board PC beeper	

Figure 4. Audio Jack Socket and ATAPI Connectors



2.6.1 Audio Channel Allocation

Connector type	**I/O panel jack**		**Internal header**		
I/O panel jack color	Pink	Lime	Blue*		
ATAPI header color			Black*	White	Yellow
Nominal function	Microphone	Line Out	Line In	Microphone	Line out
Line In capability	X		X		
Line Out capability		X			X
Microphone capability	X			X	
Headphone out capability		X			

The standard configuration is a 2 jack external connector. If a 3 jack external connector is needed, an option could be made available, for which the added blue jack would be Line In, displacing the Line In black internal header (deleted) on the standard configuration. The internal headers do not support plug and play (jack sensing).

TIP It is possible to use both header and I/O panel jack at the same time when configured as a LINE output but this can affect drive levels depending on the load impedance.

2.7 Network

Either one or two IEEE 802.3 compatible Ethernet ports are available as build options that are based around Intel controllers 82573L or 82562GZ to provide 10/100/1000Mbps or 10/100Mbps configurations. Connection to the network is achieved through two RJ45 connectors, available on the rear panel, which have integral LEDs to provide Link status information.

10/100/1000 BASE-T Gigabit Ethernet Controller (Intel 82573L)

- Uses x1 PCI-Express on ICH7/7R
- Peak bandwidth 2Gbps per direction
- PCI-Express power management
- Optimized transmit and receive queues
- IEEE802.3x compliant flow control support with software controllable pause times and threshold values
- Integrated PHY for 10/100/1000 Mbps full and half duplex operation
- Advanced packet filtering
- Intel Active Management Technology
- Supports ASF 1.0 and 2.0 alerting
- Supports Wake On LAN (WOL) and ACPI
- Programmable LED functionality
- Loop-back capabilities
- IEEE 802.3ab Auto-Negotiation support

10/100BASE-TX Fast Ethernet Controller (Intel 82562GZ)

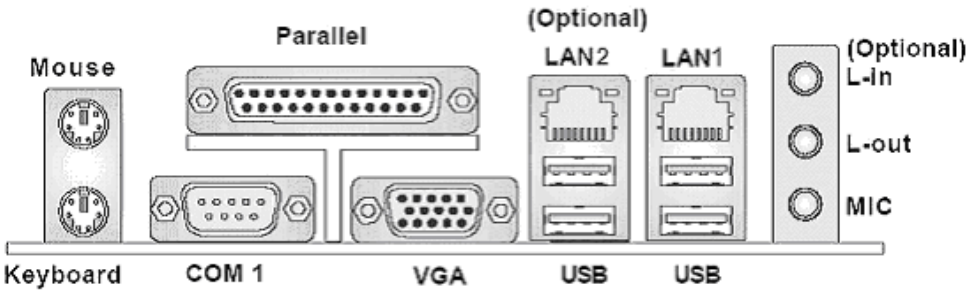
- IEEE 802.3 10BASE-T/100BASE-TX compliant physical layer interface
- IEEE 802.3u Auto-Negotiation support
- Digital Adaptive Equalization control
- Link status interrupt capability
- 3-port LED support (speed, link and activity)
- 10BASE-T auto-polarity correction
- LAN Connect interface
- Alert on LAN Functionality, ASF 1.0 alerting
- Diagnostic loop-back mode
- 1:1 transmit transformer ratio support
- Low power (less than 300 mW in active transmit mode)
- Reduced power in unplugged mode (less than 50 mW)
- Automatic detection of unplugged mode

2.8 Standard PC I/O

The rear I/O ports include:

- PS/2 keyboard and mouse
- Analog VGA
- Bi-directional/EPP/ECP parallel port
- COM1 RS232
- One or two dual USB + RJ45 stacks
- Audio jack stack (2 jacks)

Figure 5. Rear I/O Connectors



2.9 USB Ports

- Four USB 2.0 ports on I/O panel via two dual stacked USB over RJ45 connectors
- Four USB 2.0 ports on internal locking headers

2.10 General Purpose I/O Lines

To support products that require a small number of internal input or output lines (such as switches or LED indicators), the motherboard provides access to 13 general-purpose lines by a 20-pin header. 13 lines can be programmed as inputs or outputs. It is the responsibility of the customer to provide suitable software to control these lines. For detailed pin definition, please refer to the appendix ‘General Purpose I/O headers’.

2.11 CMOS RAM & RTC

The chipset integrates real-time clock (RTC) and 256 bytes of CMOS RAM that is used by the BIOS to store configuration information. A replaceable primary lithium “coin cell” battery (type CR2032) backs up both the RTC and the CMOS RAM, and provides approximately 5 years of un-powered backup.

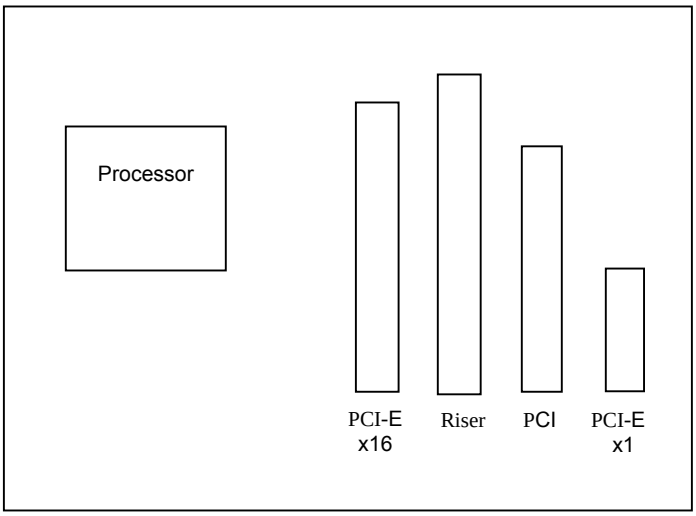
When available, the RTC and CMOS RAM are powered from the +3.3V standby power rather than the lithium battery cell. The system management hardware can monitor the lithium cell voltage directly.

2.12 Expansion Cards

The motherboard provides two bus-master 5V PCI 2.3 compliant slots, one PCI Express x1 slot, and one PCI-E x16 slot. The motherboard generates the 3.3Vaux supply to these slots using the 5V standby input from the power supply. Always ensure that the 5V standby rail can support the required current when using a PCI card that makes use of the 3.3Vaux supply.

Figure 6 shows the slot layout of EM945G board. PCI-E X1 is the PCI Express x1 slot. PCI_SLOT1 and PCIRISER_SLOT1 are the PCI 2.3-compliant 5V 33MHz 32bit slots. PCI Express (x16) graphic cards and ADD2 cards are supported at PCI-E x16 slot.

Figure 6. EM945G Board Slot Layout



2.13 System Management

The motherboard includes hardware system management functions by the National Semiconductor LM96000 device. They monitor system voltages, motherboard, processor and external temperatures, fan speed and control system fans. The following sections describe this in detail.

2.13.1 Voltage Monitoring

The following table details the motherboard voltage rails monitored and their usage.

Voltage Rail	Usage on Motherboard
+12V	Fans, expansion slots
+5.0V	Processor voltage regulator, internal voltage regulator for chipset and system memory, internal logic, USB and video ports, expansion slots
VCPU	Processor core voltage
VBAT	This internal rail is used to power the RTC and the CMOS RAM

The processor voltage regulator generates the operating voltage automatically based on the processor voltage requirement indicated by the processor by the VID pins. The VID

can be read by the control logic General Control and Status register (VID-5) and the System Management Controller (LM96000) on the SMBUS (VID0-4).

2.13.2 Temperature Monitoring

There are three thermal monitors, two of which connect to temperature sensors on the motherboard. The first measures the motherboard temperature using a sensor contained within the LM96000. This is a localized reading dominated by the motherboard surface temperature around the component. The second temperature sensor is located on the processor die and thus accurately measures the local die temperature. Since the local die temperature fluctuates rapidly with activity, the controller within the LM96000 filters the signal to produce an average temperature.

NOTE There is temperature deviation across the processor die that cannot be observed by this sensor. Intel provides information on this in the processor datasheet. A third sensor can be connected to the motherboard using the external sensor connector. The sensor should be a silicon diode or transistor connected as a diode, such as a Fairchild MMBT3904.

2.13.3 Fan Monitoring

The motherboard supports three fan monitors that check the fan tachometer signals to determine the rotational speed. Fan speeds can be monitored by software to provide early warning of a failing fan, indicated by a slower than normal rotational speed.

NOTE When a fan is temperature controlled, the speed is determined by the control mechanism and the fan will sometimes be intentionally slowed or stopped – monitoring software must accommodate this.

The three fan tachometer monitors are assigned to the fans as follows:

Fan Monitor	Usage by motherboard
Fan monitor 1	Processor fansink (see motherboard layout section)
Fan monitor 2	System fan (see motherboard layout section)
Fan monitor 3	System fan (see motherboard layout section)

2.13.4 Fan Control

The motherboard supports individual variable speed controls for the processor fansink and the two system fans by pulse-width modulation of the fan drive output voltage. In addition to direct software control, the LM96000 supports automatic fan control based on the temperature indicated by the three thermal sensors. Each sensor defines a thermal zone and the fans can then be independently assigned to these zones. Parameters defining PWM frequency, temperature range, spin-up delays etc. are programmed into the LM96000 to enable automatic control. The default parameter set programmed by the BIOS can be customized.

2.13.5 Tamper Detection

The motherboard supports tamper detection security that operates by a chassis tamper switch connected to the front panel connector. When the motherboard detects this signal low the BIOS can be configured to display a warning message or to require a password at the next boot. Since the lithium cell powers the logic, the tamper detection continues to operate even if the board is un-powered.

2.14 Power Management

The EM945G motherboard implements a number of power management features via ACPI.

2.14.1 ACPI Power States

- Supports ACPI 2.0 with power states S0, S3, S4 (not S4BIOS), S5 and C0, C1
- Supports PCI PME and PCI Express power management event signaling

The following table shows the ACPI power states:

G0/S0/C0	Full on
G0/S0/C1	Processor is halted
G1/S3	System context is saved to RAM and power removed from all circuits except that required to maintain system RAM and resume
G1/S4	System context is saved to disk and power removed from all circuits except that required to resume
G2/S5	Soft off, only resume logic and RTC remain powered

2.14.2 ACPI Wake-up Support

The following table indicates which events can cause an ACPI wake-up and from which sleep states:

Wake-Up Event	From ACPI State	Note
Power button	S1, S3, S4*[1], S5	BIOS setting
RTC alarm	S1, S3, S4*[1], S5	BIOS setting
LAN	S1, S3, S4*[1], S5	BIOS setting
1394B	S1, S3	BIOS setting
USB	S1, S3	BIOS setting
PCI	S1, S3, S4*[1], S5	Via PME# signal
PS/2	S1, S3	BIOS setting
Serial port	S1, S3, *S4, S5	S4 and S5 support External Modem only

*[1] S4 implies OS support only (Win 2000, Win XP)

2.15 Power State Indicators

The motherboard supports a single dual-color LED indicator that shows power status. It is possible to use a single-color LED although some functionality is lost.

The following table describes how the indicator is driven when operating with both single and dual-color devices and assumes 5V standby power is available.

LED	State	Description
Single color	OFF	The motherboard is powered down or in one of the ACPI sleep states (including S1).
	ON	The motherboard is fully powered up (S0).
	Blinking	The motherboard is fully powered up (S0) with a message waiting (as determined by ACPI TAPI).
Dual Color (Green /Yellow)	OFF	The motherboard is powered down or in ACPI sleep states S4 or S5 (no +5V supply available)
	Green	The motherboard is fully powered up (S0).
	Yellow	The motherboard is in sleep state S1.
	Blinking green	The motherboard is fully powered up (S0) with a message waiting (as determined by ACPI TAPI).
	Blinking yellow	The motherboard is in sleep state S1 with a message waiting (as determined by ACPI TAPI).

2.16 BIOS

The standard BIOS for EM945G board should follow the latest specific Intel 945G chipset platform BIOS PRD for this product.

- Based on Phoenix Award BIOS
- 4Mbit firmware hub BIOS ROM
- System and (Intel) video BIOS
- Intel Ethernet remote boot and PXE code
- Fully customizable including video BIOS
- ROM can be optionally socketed with write-protect support
- Silent boot (boot message hiding, logo visible), headless operation support
- All configuration is automatic - no stopping on configuration change
- Resources freed when unused

2.17 Operating Systems Support

The following operating systems are validated by RadiSys with the EM945G motherboard.

- Windows XP Professional SP2
- Embedded Windows XP Server SP2
- Red Hat Enterprise Linux 4.0 AS

- Knoppix Linux 3.7
- Windows 2000 Server SP4
- SUSE Linux Enterprise Server 9.0

Contact RadiSys for information on the support of other operating systems. For device drivers, see the Manuals, Drivers & BIOS section on www.radisys.com.

3. Specifications

The following sections specify the conditions required for correct operation of the motherboard, usage information and regulatory and industry compliance statements. Failure to operate the product within its specification can result in system failures or reduce product lifetime.

3.1 Environmental

The following table details the environmental operating limits and the calculated product reliability data:

Characteristic	State	Value
Temperature (ambient)	Operating	0°C to +55°C Operation above +30° C reduces the maximum operational relative humidity.
	Operating gradient	±5°C per minute
	Storage	-40°C to +85°C, 5°C per minute maximum excursion gradient.
Relative humidity	Operating	10% to 85% RH non-condensing at +30°C, linearly decreasing to 5% to 15.5% RH non-condensing at +65°C.
	Storage	5% to 90% RH non-condensing at +40° C.
Vibration	Operating	Random 5Hz to 2kHz, 7.7grms, 10 mins in each of 3 axes 5Hz to 20Hz: 0.004g2/Hz ramping up to 0.04g2/Hz; 20Hz to 1000Hz: 0.04g2/Hz; 1000Hz to 2000Hz: 0.04g2/Hz ramping down to 0.01g2/Hz
	Packaged	Random 5Hz to 2kHz, 9.7grms, 10 min. in each of 3 axes 5Hz to 20Hz: 0.006g2/Hz ramping up to 0.06g2/Hz; 20Hz to 1000Hz: 0.06g2/Hz; 1000Hz to 2000Hz: 0.06g2/Hz ramping down to 0.02g2/Hz Sine 5Hz to 500Hz, 0.15 octave/min up and back, 10 min. dwell at 3 resonances in each of 3 axes 5 to 50Hz swept – 0.1g; 50 to 500Hz swept – 0.25g
Shock	Non-Operating	30g 11ms, half-sine
	Packaged	Drop test, 10-up bulk packaging, 30 inches free-fall, 152 inches/s velocity change
Altitude	Operating	To 15000 ft. (4500m)
	Storage	To 40000 ft. (12000m)

Characteristic	State	Value
MTBF	MTBF (hr) predictions for the EM945G products are as follows:	
	SKU	55°C	35°C
	EM1W00-0-0	148,730	303,859
	EM2G00-0-0	145,334	296,203
Airflow	Base on standard Intel guidelines	
Fuses	Self-resetting PTC fuse (fuses automatically reset without user intervention once the load had been removed)	

3.2 Thermal

The ambient operating temperature range for the motherboard is 0 to 55°C, but the selection of processor and heatsink (fansink) can reduce the system operating range. The processor and heatsink combination normally supplied as standard with the motherboards are tested by RadiSys to the full operating range, using software designed to cause maximum power dissipation in the processor. The test has been done in an environmental test chamber with forced-air circulation. The maximum operating temperature of the supplied processor and heatsink combination is specified in the Endura Processor Support documentation, available on the RadiSys Web site, Support & Service page.

WARNING Always test the final system configuration to determine if the operating temperature range limits for the motherboard and processor are being met. Failure to do so can lead to unstable operation, motherboard or processor damage and/or shortened life.

3.3 Regulatory EMC Compliance

When correctly installed in a suitable chassis, the EM945G motherboard is designed to meet these EMC regulations:

- CISPR 22: 1998, Class B
- EN55022, EN55024
- FCC Class B

3.4 Regulatory Safety Compliance

When correctly installed in a suitable chassis, the EM945G motherboard is designed to meet these safety regulations:

- UL60950, CSA60950, EN60950, IEC60950
- CB report to IEC60950-1 with all deviations
- Accessory listing from UL to UL60950-1

3.5 Industry Compliance

The EM945G motherboard implements the industry specifications shown in the following table.

Specification	Description	Revision
ACPI	Advanced Configuration and Power Interface Specification	2.0
ATAPI	ATA Packet Interface for CD-ROMs	2.5
ATX	ATX Motherboard Form Factor Specification	2.03
MicroATX	MicroATX Motherboard Interface Specification	1.1
PCI	PCI Express Base Specification	1.0
	PCI Express Card Electromechanical Specification	1.0a
	Peripheral Component Interconnect Local Bus Specification	2.2
	PCI Power Management Interface Specification	1.1
USB	Universal Serial Bus Specification	2.0

3.6 Miscellaneous Specifications

Parameter	Conditions	Specification
RTC Clock accuracy	25°C, 3.3V	+/- 10 ppm max.
Processor fan drive capability	12.0V	1400mA max.
System fan drive capability	12.0V	280mA max.

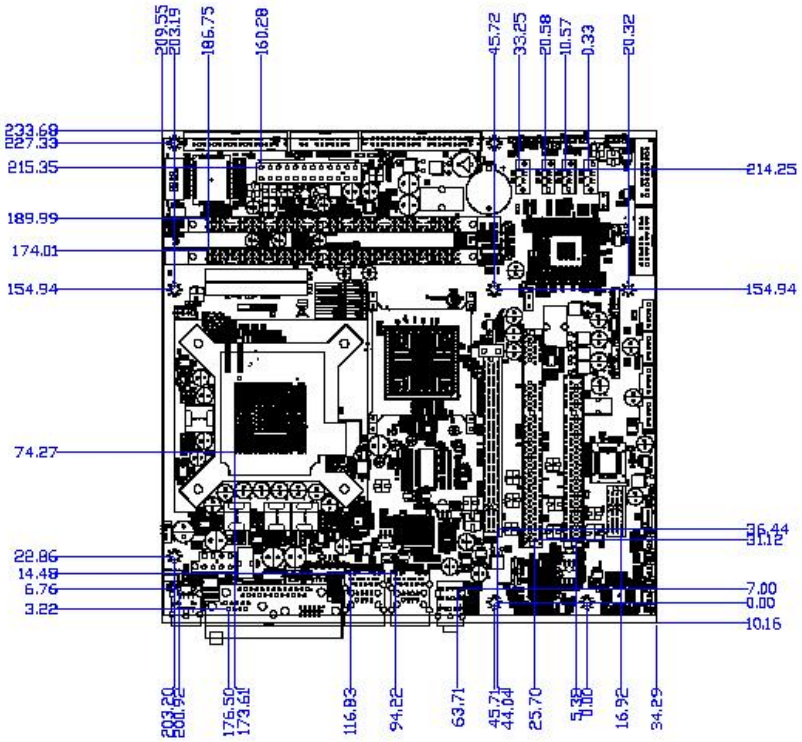
3.7 Mechanical

3.7.1 Motherboard

The EM945G motherboard meets the microATX Motherboard Interface Specification v1.1 and the ATX Specification, v2.03. It measures 9.6 x 9.6 inches and is manufactured using a 4-layer PCB with components on the topside only. The screen-printing includes:

- Product Name, RadiSys branding
- Location for serial number and product labels
- Selected component reference designators
- Safety logo

Figure 7. Motherboard Dimensions



3.7.2 I/O Shield

There are two I/O shields, one for the single Ethernet configuration and one for the dual Ethernet configuration. These are separately orderable product codes.

Motherboard	I/O Shield Product Code
EM1W0x-0-0	(single LAN) ATX-L BL IOSHLDR
EM2G0x-0-0	(dual LAN) ATX-2L BLK IOSHLDR

3.7.3 Heatsinks

The following heatsink and fansink solutions are supported:

- Two different Processor fansinks are offered as separate RadiSys products, FNSNK P4-775 HR (FNSINK - LGA775 P4, ATX HI PERF ROHS) and FNSNK P4-775 R (FNSINK - LGA775 P4, ATX ROHS)
- Processor – fansink for Intel Pentium 4 processor, 12V with speed control and monitoring (4-wire fan) is recommended
- 945G GMCH – clip-on passive heatsink
- ICH7(R) – clip-on passive heatsink
- Ethernet controller (heatsink not required)

3.8 Electrical

3.8.1 Motherboard Power Consumption

The motherboard power consumption is highly dependent on the processor, memory and devices attached, software that is running, and the power state that the board is in.

The following figures are for a sample Real System, DUT EM945G No. 0:

- Power Supply: FSP350-60PLN/350W
- Current Meter: PROVA CM-01 AC/DC Clamp Meter
- Drives: Powered independently
- Hard Drive Disk: Maxtor Diamond Plus9 80GB 7200 IDE Disk
- Network: On-board (Dual GbE LAN, not operating)

Based on the Heavy Load and Light Load configurations, verify the power requirements to expect under selected conditions, which are based on measurements of sample real system configurations:

Heavy Load Configuration

Memory: MT16HTF DDR2-400 1GB X2 CL3

Video: On-board (8MB shared Memory)

Network: On-board (Dual GbE LAN, not operating)

Intel Pentium 4 at 3.4GHz with 800MHz processor bus

Mode	Motherboard Current (A)						Power
	+3.3V	+5V	+12V	+12V(CPU)	-12V	+5Vsby	Total (W)
MS-DOS Prompt without power management	0.42	3.38	0.32	8.52	0.02	0.02	124.706
Windows XP desktop idle	0.43	3.40	0.34	1.72	0.02	0.02	43.479
Windows XP hibernate (S4)	0.00	0.00	0.00	0.00	0.00	0.12	0.6
Windows XP shutdown	0.00	0.00	0.00	0.00	0.00	0.18	0.9
Windows XP standby (S1)	0.33	3.08	0.38	3.30	0.03	0.02	61.109
Windows XP standby (S3)	0.00	0.00	0.00	0.00	0.00	0.39	1.95
Windows XP stress test (3DMark03)	0.43	4.55	0.39	8.50	0.03	0.02	131.309
Windows XP stress test (PCMark04)	0.43	3.25	0.35	8.27	0.03	0.02	121.569
Windows XP stress test (Intel Maxpower v1.4.2)	0.43	3.27	0.35	8.20	0.03	0.02	120.829

Light Load Configuration

Memory: MT8HF DDR2-400 CL3 256MB

Video: On-board (8MB shared Memory)

Network: On-board (Dual GbE LAN, not operating)

Intel Celeron 4 at 2.93GHz with 533MHz processor bus

Mode	Motherboard Current (A)						Power
	+3.3V	+5V	+12V	+12V(CPU)	-12V	+5Vsby	Total (W)
MS-DOS Prompt without power management	0.43	2.51	0.33	4.45	0.02	0.02	71.669
Windows XP desktop idle	0.42	2.52	0.34	3.97	0.02	0.02	66.046
Windows XP hibernate (S4)	0.00	0.00	0.00	0.00	0.00	0.16	0.8
Windows XP shutdown	0.00	0.00	0.00	0.00	0.00	0.25	1.25
Windows XP standby (S1)	0.31	2.13	0.33	1.71	0.02	0.02	36.493
Windows XP standby (S3)	0.00	0.00	0.00	0.00	0.00	0.16	0.8
Windows XP stress test (3DMark03)	0.43	3.54	0.33	4.62	0.02	0.02	78.859
Windows XP stress test (PCMark04)	0.43	2.84	0.33	4.80	0.02	0.02	77.519
Windows XP stress test (Intel Maxpower v1.4.2)	0.43	2.76	0.33	6.36	0.02	0.02	95.839

3.8.2 Power Delivery to Expansion Slots

The following table indicates the maximum expansion slot current that should be drawn from each expansion slot. Do not exceed the limits for each slot or voltage rail. PCI slots are limited to 25W in total on the main +5.0V and +3.3V supplies, all of which can be drawn from either voltage rail. The figures for the riser are for the total current/power delivered to the riser through the motherboard. If more is required, the riser must draw power from an additional source such as a separate power connector from the PSU.

Slot	+3.3V	+5V	+12V	–12V	+3.3Vaux*[1]
PCI-E x1	3.0A (9.9W)	N/A	0.5A (6W)	N/A	375mA/20mA (1.3W/0.1W)
PCI-E x16	3.0A (9.9W)	N/A	5.5A(67.2W)	N/A	375mA/20mA (1.3W/0.1W)
PCI	7.6A (25W)*[2]	5.0A (25W) *[2]	0.5A (6W)	100mA (1.2W)	375mA/20mA (1.3W/0.1W)

*[1] One wake-enabled card is at 375mA and the remainder at 20mA.

*[2] The combined PCI slot power consumption via the +3.3V and +5.0V supplies is a maximum of 25W.

3.8.3 Power Supply Selection

It is recommended that the board be used with a power supply that supports a minimum current load of 0.3A or less on the 3.3V supply rail and 2A or less on the 5V supply rail.

This board with CPU and memory may draw as little as 400mA of 3.3V and 2A of 5V during start-up (increases depend on installed devices). The power supply under consideration must be verified as compatible with the projected total system start-up loads for these supply rails. If the power supply minimum current level requirements are not at or below the level of current loads that are actually drawn, unpredictable start-up operation may result, such as the power supply latching off. If this occurs, the AC input to the power supply must be removed and re-attached or the power supply switch cycled off and on, in order to turn the system back on.

The following table shows the appropriate power supply selections.

Voltage Rail	Tolerance	Voltage Rail	Tolerance
+5.0V DC	± 5%*[1]	+3.3V DC	± 5%
+12.0V DC	± 5%	+5.0V DC standby	± 5%
-12.0V DC	± 5%		

*[1] To meet the USB output supply voltage specification, the minimum +5V should be 4.90V

4. Appendices

4.1 Industry Standard References

Description	Location
ACPI	www.acpi.info
Intel® 945G chipset datasheet	www.intel.com/products/chipsets/945G
Intel Celeron® processor datasheet	http://developer.intel.com/design/celeron
Intel Pentium® 4 processor datasheet	http://developer.intel.com/design/pentium4
Form factor specifications	www.formfactors.org
Memory module specifications	http://developer.intel.com/technology/memory www.jedec.org
SMBus	www.smbus.org
PCI local bus specification	www.pcisig.com
USB	www.usb.org/developers
VESA	www.vesa.org

4.2 Connector Descriptions

For detailed information about connector locations, refer to the Motherboard Layout and Component Identification diagram.

4.2.1 Connector Part Numbers

The various motherboard connectors are listed in the following table along with the part number of one of the approved vendors. The list is intended to assist in the selection of mating connectors.

Connector	Part Number	Type
I/O panel dual USB	Foxconn UB1112C-8MD1-4F	Dual vertically stacked USB
I/O panel 10/100 RJ45 over dual USB	Foxconn JFM25U1B-21U5-4F	RJ45 with LEDs and transformer over dual USB, 10/100
I/O panel Gbit RJ45 over dual USB	Foxconn JFM38U1B-21U5-4F	RJ45 with LEDs and transformer over dual USB, Gbit
I/O panel PS/2 keyboard and mouse	Foxconn MH11067-F7D2-4F	Stacked 6-way mini-DIN
I/O panel VGA monitor (D-SUB 3 IN 1)	Foxconn DM11352-H5V3-4F	15-way high-density female D-sub
I/O panel Serial port (D-SUB 3 IN 1)	Foxconn DM11352-H5V3-4F	9-way male D-sub
I/O panel Parallel port (D-SUB 3 IN 1)	Foxconn DM11352-H5V3-4F	25-way female D-sub
I/O panel double stack audio jacks	Foxconn JA2333L-HA6Q-4F	Double vertically stacked 3.5mm

Connector	Part Number	Type
ATAPI CD-ROM Audio Line-In Header	NIKETECH 271S04-A01A	4-way header with latch, black
Keyboard and Mouse headers	Foxconn HF5504E	4-pin 2mm headers
ATAPI Audio Line-Out Header	NIKETECH 271S04-A08A	4-way header with latch, yellow
ATX12V Power Connector	Foxconn HM3504E-EP1	2 by 4-way ATX power header
ATAPI Audio Microphone-In Header	NIKETECH 271S04-A07A	4-way header with latch, white
Processor Fan, System FAN1 and FAN2 Header	Foxconn HF0804E-M2	4-way with locking ramp
Processor Socket	Foxconn PE077507-0941-01	775-pin FC-LGA4
SMBUS Header	Foxconn HF5504E	4-pin 2mm header
x1 PCI-E Slot	Foxconn 2EG0181V-D2D	1 Lane differential pairs signaling
PCI Slot	Foxconn EH0600V-DAW	3.5V/5V signaling
x16 PCI-E Slot	Foxconn 2EG0821V-D2D	16 Lane differential pairs signaling
USB Port 5,6,7,8 headers	NIKETECH 271S05-A01A	5-pin locking ATAPI-style, black
Remote Thermal Sensor Header	Foxconn HF5502E-N	2-pin 2mm header
Lithium cell holder	LOTES B6615BP5Q	Top loading, CR2032
DIMM Sockets	Foxconn AT24007-H3BE-4F	240-pin, 1.8V DDR2 SDRAM
Front Panel Header	Foxconn HC11101-L6	2 by 10-way header
RS232 Serial Port2 Header	Foxconn HL20051-D1	2 by 5-way shrouded header
SATA Port 1 and Port 2 Header	Foxconn LD1807V-S51B	2 differential pairs signaling
TPM Header	Foxconn HL20101-P0	2 by 10-way header
ATX Power Connector	Foxconn HM3512E-EP1	2 by 12-way ATX power header
GPIO Header	Foxconn HL20101-L7	2 by 10-way shrouded header
Diskette Connector	Foxconn HL20171-P4	34-pin shrouded header
Primary IDE Connector	Foxconn HL20201-UD2	40-pin shrouded header

4.2.2 Expansion Slots

PCIe x16 Expansion Slot

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	PRSNT1#	B1	12V	A42	GND	B42	HSON6
A2	12V	B2	12V	A43	HSIP6	B43	GND
A3	12V	B3	RSVD	A44	HSIN6	B44	GND
A4	GND	B4	GND	A45	GND	B45	HSOP7
A5	JTAG2	B5	SMCLK	A46	GND	B46	HSON7
A6	JTAG3	B6	SMDAT	A47	HSIP7	B47	GND
A7	JTAG4	B7	GND	A48	HSIN7	B48	PRSNT2_B4
A8	JTAG5	B8	3.3V	A49	GND	B49	GND
A9	3.3V	B9	JTAG1	A50	RSVD	B50	HSOP8
A10	3.3V	B10	3.3VAUX	A51	GND	B51	HSON8
A11	PWRGD	B11	WAKE#	A52	HSIP8	B52	GND
A12	GND	B12	RSVD	A53	HSIN8	B53	GND
A13	REFCLK+	B13	GND	A54	GND	B54	HSOP9
A14	REFCLK-	B14	HSOP0	A55	GND	B55	HSON9
A15	GND	B15	HSON0	A56	HSIP9	B56	GND
A16	HSIPO	B16	GND	A57	HSIN9	B57	GND
A17	HSINO	B17	PRSNT2_B1	A58	GND	B58	HSOP10
A18	GND	B18	GND	A59	GND	B59	HSON10
A19	RSVD	B19	HSOP1	A60	HSIP10	B60	GND
A20	GND	B20	HSON1	A61	HSIN10	B61	GND
A21	HSIP1	B21	GND	A62	GND	B62	HSOP11
A22	HSIN1	B22	GND	A63	GND	B63	HSON11
A23	GND	B23	HSOP2	A64	HSIP11	B64	GND
A24	GND	B24	HSON2	A65	HSIN11	B65	GND
A25	HSIP2	B25	GND	A66	GND	B66	HSOP12
A26	HSIN2	B26	GND	A67	GND	B67	HSON12
A27	GND	B27	HSOP3	A68	HSIP12	B68	GND
A28	GND	B28	HSON3	A69	HSIN12	B69	GND
A29	HSIP3	B29	GND	A70	GND	B70	HSOP13
A30	HSIN3	B30	RSVD	A71	GND	B71	HSON13
A31	GND	B31	PRSNT2_B3	A72	HSIP13	B72	GND
A32	RSVD	B32	GND	A73	HSIN13	B73	GND
A33	RSVD	B33	HSOP4	A74	GND	B74	HSOP14
A34	GND	B34	HSON4	A75	GND	B75	HSON14
A35	HSIP4	B35	GND	A76	HSIP14	B76	GND

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A36	HSIN4	B36	GND	A77	HSIN14	B77	GND
A37	GND	B37	HSOP5	A78	GND	B78	HSOP15
A38	GND	B38	HSON5	A79	GND	B79	HSON15
A39	HSIP5	B39	GND	A80	HSIP15	B80	GND
A40	HSIN5	B40	GND	A81	HSIN15	B81	PRSNT2_B8
A41	GND	B41	HSOP6	A82	GND	B82	RSVD

PCIe x1 Expansion Slot

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	PRSNT1#	A10	3.3V	B1	12V	B10	3.3VAUX
A2	12V	A11	PWRGD	B2	12V	B11	WAKE#
A3	12V	A12	GND	B3	RSVD	B12	RSVD
A4	GND	A13	REFCLK+	B4	GND	B13	GND
A5	JTAG2	A14	REFCLK-	B5	SMCLK	B14	HSOP0
A6	JTAG3	A15	GND	B6	SMDAT	B15	HSON0
A7	JTAG4	A16	HSIPO	B7	GND	B16	GND
A8	JTAG5	A17	HSINO	B8	3.3V	B17	PRSNT2_B1
A9	3.3V	A18	GND	B9	JTAG1	B18	GND

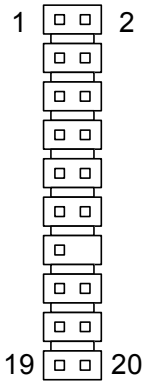
PCI Expansion Slot

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	TRST#[13]	B1	-12V	A32	AD16	B32	AD17
A2	+12V	B2	TCK[13]	A33	+3.3V	B33	C/BE2#
A3	TMS[14]	B3	GND	A34	FRAME#	B34	GND
A4	TDI[14]	B4	TDO[1]5	A35	GND	B35	IRDY#
A5	+5V	B5	+5V	A36	TRDY#	B36	+3.3V
A6	INTA#	B6	+5V	A37	GND	B37	DEVSEL#
A7	INTC#	B7	INTB#	A38	STOP#	B38	GND
A8	+5V	B8	INTD#	A39	+3.3V	B39	LOCK#
A9	CLKRUN#[15]	B9	PRSNT1#	A40	Not Used	B40	PERR#
A10	+5V	B10	Reserved	A41	Not Used	B41	+3.3V
A11	Reserved	B11	PRSNT2#	A42	GND	B42	SERR#
A12	GND	B12	GND	A43	PAR	B43	+3.3V
A13	GND	B13	GND	A44	AD15	B44	C/BE1#
A14	+3.3V AUX	B14	Reserved	A45	+3.3V	B45	AD14
A15	RST#	B15	GND	A46	AD13	B46	GND
A16	+5V	B16	CLK	A47	AD11	B47	AD12
A17	GNT#	B17	GND	A48	GND	B48	AD10
A18	GND	B18	REQ#	A49	AD9	B49	GND

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A19	PME#	B19	+5V	A50	KEY	B50	KEY
A20	AD30	B20	AD31	A51	KEY	B51	KEY
A21	+3.3V	B21	AD29	A52	C/BE0#	B52	AD8
A22	AD28	B22	GND	A53	+3.3V	B53	AD7
A23	AD26	B23	AD27	A54	AD6	B54	+3.3V
A24	GND	B24	AD25	A55	AD4	B55	AD5
A25	AD24	B25	+3.3V	A56	GND	B56	AD3
A26	IDSEL	B26	C/BE3#	A57	AD2	B57	GND
A27	+3.3V	B27	AD23	A58	AD0	B58	AD1
A28	AD22	B28	GND	A59	+5V	B59	+5V
A29	AD20	B29	AD21	A60	REQ64#	B60	ACK64#
A30	GND	B30	AD19	A61	+5V	B61	+5V
A31	AD18	B31	+3.3V	A62	+5V	B62	+5V

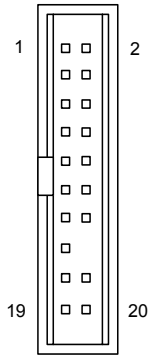
4.2.3 Connectors for Internal Devices

Front Panel Header



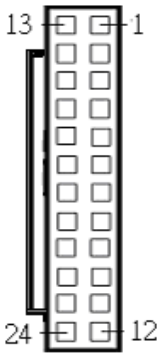
Pin	SIGNAL	Pin	SIGNAL
1	HDLED+ (Anode)	2	GREEN (Green LED anode)
3	HDLED- (Cathode)	4	YELLOW (Yellow LED anode)
5	GND	6	PWRSW# (Reference to GND)
7	RESET# (Reference to GND)	8	GND
9	+5V (Fused)	10	+5V (Fused, speaker power)
11	Not Used	12	SPKR# (Speaker return)
13	GND	14	KEY (no pin fitted)
15	GREEN (Green LED anode)	16	SPKR# (Speaker return)
17	Not Used	18	TAMPER# (Reference to GND)
19	YELLOW (Yellow LED anode)	20	GND

General Purpose I/O Headers



Pin	SIGNAL	Pin	SIGNAL
1	GND	2	GPIO_FUSED5V
3	GND	4	GPIOE10
5	GPIOE11	6	GPIOE12
7	GPIOE0	8	GPIOE1
9	GPIOE2	10	GPIOE3
11	GPIOE4	12	GPIOE5
13	GPIOE6	14	GPIOE7
15	+3.3V_FUSED	16	KEY (no pin fitted)
17	GND	18	GPIO13
19	GND	20	GPIO14

Power Supply Connector (ATX_2X12)

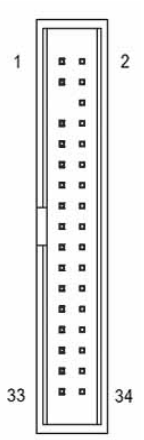


Pin	SIGNAL	Pin	SIGNAL
1	+3.3V	13	+3.3V
2	+3.3V	14	-12V
3	GND	15	GND
4	+5V	16	PSON#
5	GND	17	GND
6	+5V	18	GND
7	GND	19	GND
8	PWROK	20	Not Used
9	+5VSB	21	+5V
10	+12V	22	+5V
11	+12V	23	+5V
12	+3.3V	24	GND

Power Supply Connector (ATX_2X4)

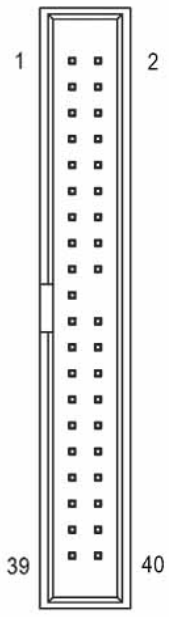
Pin	SIGNAL	Pin	SIGNAL
1	GND	5	12V_VRM
2	GND	6	12V_VRM
3	GND	7	12V_VRM
4	GND	8	12V_VRM

Floppy Disk Connector



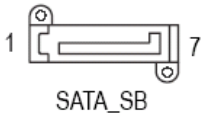
Pin	SIGNAL	Pin	SIGNAL
1	GND	18	DIP#
2	DRVDEN0	19	GND
3	NC	20	STEP#
4	NC	21	GND
5	GND	22	WD#
6	NC	23	GND
7	GND	24	WE#
8	INDEX#	25	GND
9	GND	26	TRAK0#
10	MOA#	27	GND
11	GND	28	WP#
12	DSB#	29	GND
13	GND	30	RDATA#
14	DSA#	31	GND
15	GND	32	HEAD#
16	MOB#	33	GND
17	GND	34	DSKCHG

ATA/100 Hard/Optical Drive Disk Connector



Pin	SIGNAL	Pin	SIGNAL
1	-HDRST	21	IDE REQ
2	GND	22	GND
3	Device data 7	23	I/O WRITE
4	Device data 8	24	GND
5	Device data 6	25	I/O READ
6	Device data 9	26	GND
7	Device data 5	27	I/O RDY
8	Device data 10	28	Pull down for always master
9	Device data 4	29	IDE ACK
10	Device data 11	30	GND
11	Device data 3	31	IRQ14
12	Device data 12	32	NC
13	Device data 2	33	Device address 1
14	Device data 13	34	NC
15	Device data 1	35	Device address 0
16	Device data 14	36	Device address 2
17	Device data 0	37	Device chip select S1
18	Device data 15	38	Device chip select S3
19	GND	39	HDDLED
20	NC	40	GND

SATA Disk Connector



Pin	SIGNAL	Pin	SIGNAL
1	GND	5	B-
2	A+	6	B+
3	A-	7	GND
4	GND		

Internal Audio Headers

Pin	SIGNAL
1	LEFT
2	GND
3	GND
4	RIGHT

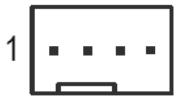
4 X Internal USB Headers

Pin	SIGNAL
1	+5V (fused)
2	DATA-
3	DATA+
4	GND
5	GND

Remote Thermal Sensor

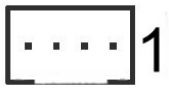
Pin	SIGNAL
1	DIODE+
2	DIODE-

3 x Fan Connector



Pin	SIGNAL
1	GND
2	+12V
3	TACH
4	PWM

SMBus Connector

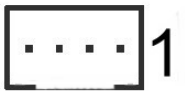


Pin	SIGNAL
1	+3.3V
2	DATA
3	CLOCK
4	GND

PS/2 keyboard Header

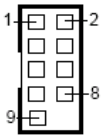
Pin	SIGNAL
1	+5V (fused)
2	DATA
3	GND
4	CLOCK

PS/2 Mouse Header



Pin	SIGNAL
1	+5V (fused)
2	DATA
3	GND
4	CLOCK

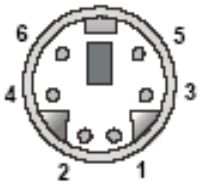
Serial Port 2 Header



Pin	SIGNAL	Pin	SIGNAL
1	DCD	6	CTS
2	DSR	7	DTR
3	RxD	8	RING
4	RTS	9	GND
5	TxD	10	KEY

4.2.4 External Device Ports

P/S2 Mouse and P/S2 Keyboard

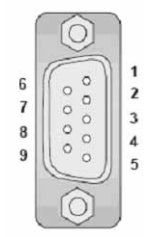


Pin	SIGNAL
1	Mouse DATA / Keyboard DATA
2	NC
3	GND
4	VCC
5	Mouse Clock / Keyboard Clock
6	NC

Parallel Port

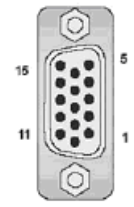
Pin	SIGNAL	Pin	SIGNAL
1	STROBE#	14	AUTO FEED#
2	DATA0	15	ERR#
3	DATA1	16	INIT#
4	DATA2	17	SLIN#
5	DATA3	18	GND
6	DATA4	19	GND
7	DATA5	20	GND
8	DATA6	21	GND
9	DATA7	22	GND
10	ACK#	23	GND
11	BUSY	24	GND
12	PE	25	GND
13	SELECT		

Serial Port 1



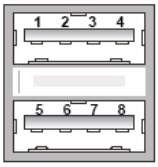
Pin	SIGNAL	Pin	SIGNAL
1	DCD	6	DSR
2	SIN	7	RTS
3	SOUT	8	CTS
4	DTR	9	RI
5	GND		

VGA Port



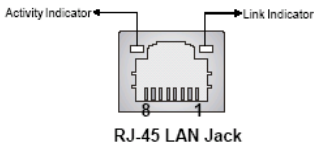
Pin	SIGNAL	Pin	SIGNAL
1	RED	9	+5V
2	GREEN	10	GND
3	BLUE	11	NC
4	NC	12	SDA
5	GND	13	Horizontal Sync
6	GND	14	Vertical Sync
7	GND	15	SCL
8	GND		

2 x Dual Stack USB Ports



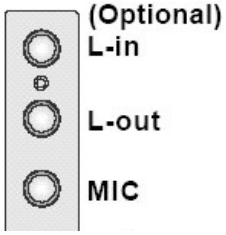
Pin	SIGNAL	Pin	SIGNAL
1	VCC	5	VCC
2	DATA0-	6	DATA1-
3	DATA0+	7	INIT#
4	GND	8	SLIN#

LAN Jack



For 10/100Mbps			
Pin	**SIGNAL**	**Pin**	**SIGNAL**
1	TxD+	5	75R Terminator
2	TxD-	6	RxD-
3	RxD+	7	75R Terminator
4	75R Terminator	8	75R Terminator
For 10/100/1000Mbps			
Pin	**SIGNAL**	**Pin**	**SIGNAL**
1	A+	5	C-
2	A-	6	B-
3	B+	7	D+
4	C+	8	D-

Parallel Port



Pin	SIGNAL
TIP	LEFT AUDIO
RING	RIGHT AUDIO
SLEEVE	GND
Remark	L-in OPTIONAL